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Feeding habits of the Stone marten *Martes foina* and environmental factors in western France

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The stone marten *Martes foina* Erxleben, 1777 has been portrayed as an omnivorous feeder (Waechter 1975; Delibes 1978; Amores 1980; Chotolchu et al. 1980; Clement and Saint-Girons 1982; Holisova and Orbtel 1982; Kalpers 1983; Rasmussen and Madsen 1985; Skirnisson 1986; Tester 1986; Romanowski and Lesinski 1991); moreover, it has been assumed that food availabilities affect diet composition. Although some previous studies have assessed seasonal dietary patterns, only very few have attempted to evaluate in parallel resource availabilities (Lode 1991). The aim of the present investigation is to relate abiotic factors and the main resource availabilities to a detailed study of the diet of stone martens.

The study was performed in farmlands in the Brière regional Parc (47° 26′ N, 2° 14′ W) and near marshes of the Lake Grand-Lieu (47°01′ N, 1°46′ W). The climate is mild and humid, mean temperatures ranging between 21.5 °C in August (1990) (Grand-Lieu) and 2.9 °C in February (1991) (Brière), precipitation reached 851 mm per year over 140 to 153 rainy days.

In Brière, 663 scats from stone martens were collected monthly from February 1990 to November 1991, and 486 scats from July 1989 to December 1990 in Grand-Lieu, in barns used as resting places. Remains were assigned to the most specific taxon possible by examining the external characteristics and by microscopic observation of medullary hair structure and cross-section, compared with our collection and an atlas (Day 1966; Chaline et al. 1974; Debrot et al. 1982). Diet composition was estimated as frequency of occurrences. The trophic niche breadth was calculated using the Shannon index $h' = -\Sigma P_i \log_2 P_i$ where P_i was the frequency of a food category (mammals, birds, insects, fruit and other). Availability of *Microtus arvalis* was made by trapline success every second month. At each site, a line of 32 live-traps was set for 3 nights through two meadows. The relative abundance of rodents was expressed as the number of individuals captured per trapnight. The abundance of insects (mainly Orthoptera and Coleoptera) was ascertained by counting the number of individuals captured monthly in visual traps (Leberre 1969) in 3 habitats (wood, hedge, meadow). The fruit availability was estimated by ascribing a monthly rank order according to the ripeness and productivity of fruit in 3 control trees each for blackberry bush (*Rubus* sp.), sloe (*Prunus spinosa*), elder (*Sambucus nigra*) and apple tree (*Malus sylvestris*).

Dietary variations showed a clear seasonality (Brière, $\chi^2 = 159.4$, df 9, $p < 0.001$; Grand-Lieu $\chi^2 = 160.3$, df 9, $p < 0.001$). Mammals formed the bulk of the diet reaching 75 % of the winter diet in Brière and 84 % in Grand-Lieu but represented only 40 % and 31 % of the summer diet (Tab. 1). Birds were mainly consumed in spring and insects were especially found in summer. Fruit was of major importance during summer and autumn.

Table 1. Seasonal proportions of different food categories in Stone marten diet at two sites in western France

	Brière				Grand-Lieu			
	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter
Insectivores	5.4	0.0	0.0	4.6	4.7	0.0	1.4	4.9
Microtus	32.8	29.8	50.3	52.6	26.4	22.2	36.4	46.1
Other mammals	19.8	10.1	3.5	17.9	32.1	8.4	17.5	32.7
Total mammals	58.0	39.9	53.8	75.1	63.2	30.6	55.3	83.7
Birds	24.6	13.9	4.5	15.6	21.7	5.6	2.8	7.1
Insects	7.2	18.7	5.2	1.2	5.7	28.3	11.9	0.0
Fruit	7.8	25.9	35.8	6.3	7.5	33.9	25.8	4.2
Others	2.4	1.4	0.7	1.7	1.2	1.7	4.1	4.9
n prey =	*167*	*208*	*288*	*173*	*106*	*180*	*217*	*141*
h′ =	1.630	1.952	1.463	1.157	1.480	1.924	1.684	0.882

The niche breadth varied throughout the year with a minimum in winter and a maximum in summer. Annual diet was significantly different between the two sites ($\chi^2 = 24.22$, df 4, $p < 0.001$). In summer, birds represented a less important food category in Grand-Lieu than in Brière, while the proportion of insects and fruit was larger in Grand-Lieu ($\chi^2 = 14.9$, df 3, $p < 0.002$). During autumn, more insects and less fruit were eaten in Grand-Lieu than in Brière ($\chi^2 = 11.86$, df 3, $p < 0.008$). Due to the predominance of mammal prey, no significant difference appeared either in winter ($\chi^2 = 7.7$, $p > 0.05$) or in spring ($\chi^2 = 0.74$, $p > 0.8$).

Photoperiod and mean temperatures were negatively correlated with the monthly frequency of mammals in the diet (Spearman rank correlation, df 20 in Brière, df 16 in Grand-Lieu, Brière $r_s = -0.699$, $p < 0.001$ and $r_s = -0.845$, $p < 0.001$, Grand-Lieu $r_s = -0.798$, $p < 0.001$ and $r_s = -0.909$, $p < 0.001$), whereas the number of rainy days ($r_s = 0.448$, $p < 0.05$) in Brière and the number of rainy days and precipitations in Grand-Lieu were positively related ($r_s = 0.579$, $p < 0.02$, $r_s = 0.501$, $p < 0.05$). Close negative relationships were obtained between monthly frequency of *Microtus arvalis* and mean temperatures (Brière $r_s = -0.709$, $p < 0.001$, Grand-Lieu $r_s = -0.862$, $p < 0.001$) or photoperiod (Brière $r_s = 0.750$, $p < 0.001$, Grand-Lieu $r_s = -0.876$, $p < 0.001$). On the other hand, precipitation and number of rainy days were positively correlated with dietary frequency of voles (Brière $r_s = 0.494$, $r_s = 0.451$, $p < 0.05$, Grand-Lieu $r_s = 0.634$, $r_s = 0.605$, $p < 0.01$). A few insectivores were consumed during the coldest months. Other mammals eaten included long-tailed field mice (*Apodemus sylvaticus*), mice (*Mus domesticus*), brown rats (*Rattus norvegicus*), bank voles (*Clethrionomys glareolus*), water voles (*Arvicola sapidus*) and rabbits (*Oryctolagus cuniculus*). Birds were mainly passeriforms. Coleoptera and orthoptera were the most common insects found and showed correlations with photoperiod and temperatures (Brière $r_s = 0.874$, $r_s = 0.851$, $p < 0.001$, Grand-Lieu $r_s = 0.815$, $r_s = 0.934$, $p < 0.001$). Other invertebrates, mainly earthworms, were eaten in winter and spring. The frequency of fruit (*Rubus* sp., *Prunus* sp., *Sambucus niger, Malus sylvestris, Crataegus oxyacantha, Rosa canina*) correlated with temperatures (Brière $r_s = 0.544$, $p < 0.02$, Grand-Lieu $r_s = 0.806$, $p < 0.001$) and in Grand-Lieu to photoperiod ($r_s = 0.815$, $p < 0.001$), precipitations ($r_s = 0.575$, $p < 0.02$) and rainy days ($r_s = -0.623$, $p < 0.01$).

Availability of *Microtus arvalis* increased from spring to autumn (Tab. 2) but monthly variation of the trap-night index did not correlate with vole occurrence in the marten diet. Insect abundance showed an increase in summer, significantly correlated with occurrence of this category (Brière $r_s = 0.777$, $p < 0.005$ df = 12, Grand-Lieu $r_s = 0.947$, $p < 0.001$ df = 16). Fruit availability was greatest from July to October, associated with the fruit frequency in the diet (Brière $r_s = 0.894$, Grand-Lieu $r_s = 0.848$, $p < 0.001$).

Table 2. **Mean seasonal variations in availability index of three main food resources at two sites in western France**

	Brière				Grand-Lieu			
	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter
Microtus	5.2	31.2	52.0	41.6	10.4	33.9	52.1	26.0
Fruit	0.0	16.3	25.6	0.0	0.0	19.2	31.8	0.0
Insects	11.7	67.0	36.0	0.0	7.3	67.2	36.7	0.0

Characteristics of feeding habits of *Martes foina* in western France particularly illustrated the trophic opportunism of this species. The diet showed a strong seasonality with a winter/spring diet based on *Microtus* alternating with a summer/autumn exploitation of insects and fruit. Not surprisingly, the diversity index reached its lowest level in winter and increased in summer, according to the increase of food availabilities. Close relationships found between abiotic variables, food availabilities and dietary variations emphasized the decisive influence of environmental factors on feeding ecology of the stone marten.

References

Amores, F. (1980): Feeding habits of the Stone marten, *Martes foina* (Erxl., 1777) in south western Spain. Säugetierkdl. Mitt. **28**, 316–322.

Chaline, J.; Baudvin, H.; Jammot, D.; Saint-Girons, M. C. (1974): Les proies des rapaces. Paris: Doin.

Chotolchu, N.; Stubbe, M.; Dawaa, N. (1980): Der Steinmarder *Martes foina* (Erxleben, 1777), in der Mongolei. Acta Theriol. **25**, 105–114.

Clement, R.; Saint-Girons, M. C. (1982): Note sur les mammiféres de France. XVIII. Le régime de la fouine, *Martes foina* (Erxleben, 1777) dans l'agglomération nantaise et en milieu rural. Mammalia **46**, 550–553.

Day, M. G. (1966): Identification of hair and feather remains in the gut and faeces of stoats and weasels. J. Zool. (London) **148**, 210–217.

Debrot, S.; Fivaz, G.; Mermod, C.; Weber, J. M. (1982): Atlas des poils de mammifères d'Europe. Neuchatel: Institut Zool.

Delibes, M. (1978): Feeding habits of the stone marten *Martes foina* (Erxleben, 1777), in Northern Burgos, Spain. Z. Säugetierkunde **48**, 282–288.

Holisova, V.; Orbtel, R. (1982): Scat analytical data of the diet of urban stone martens, *Martes foina* (Mustelidae, Mammalia). Folia Zool. 31, 21–30.

Kalpers, J. (1983): Contribution à l'étude éco-éthologique de la fouine (*Martes foina*): stratégies d'utilisation du domaine vital et des ressources alimentaires. I. Introduction générale et analyse du régime alimentaire. Cahiers Ethol. Appl. **3**, 145–163.

Leberre, J. R. (1969): Les méthodes de piégeage des invertébrés. In: Problèmes d'écologie, l'échantillonnage des peuplements des milieux terrestres. Ed. by M. Lamotte and F. Bourliere. Paris: Mason. Pp. 54–96.

Lode, T. (1991): Exploitation des milieux et organisation de l'espace chez deux mustélidés européens, la fouine *Martes foina* et le putois *Mustela putorius*. Vie et Milieu **41**, 29–38.

Rasmussen, A. M.; Madsen, A. B. (1985): The diet of the Stone marten *Martes foina* in Denmark. Natura Jutlandica **21**, 141–144.

Romanowski, J.; Lesinski, G. (1991): A note on the diet of stone marten in southeastern Romania. Acta Theriol. **36**, 201–204.

Skirnisson, K. (1986): Untersuchungen zum Raum-Zeit-System freilebender Steinmarder (*Martes foina* Erxleben, 1777). Beitr. Wildbiol. **6**, 1–200.

Tester, U. (1986): Vergleichende Nahrungsuntersuchung beim Steinmarder *Martes foina* (Erxleben, 1777) in großstädtischem und ländlichem Habitat. Säugetierkdl. Mitt. **33**, 37–52.

Waechter, A. (1975): Ecologie de la Fouine en Alsace. Rev. Ecol. (Terre Vie) **29**, 399–457.

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